Junos Segment Routing for MPLS

JUNIPER NETWORKS | Education Services

COURSE OVERVIEW

This four-day advanced level course provides an in-depth introduction to MPLS segment routing (SR), otherwise known as Source Packet Routing in Networking (SPRING). It also includes two additional day's worth of self-study material.
The course focuses on the configuration of Juniper Networks routing and switching devices to support MPLS segment routing.
After exploring the features and use cases for SR-MPLS, students are introduced to the building blocks of a segment-routed network (namely, adjacency segment identifiers (SIDs), node SIDs, prefix SIDs and anycast SIDs). The course includes these features for both IS-IS and OSPF.
Students then learn how to use these SIDs to create label-switched paths (LSPs) and tunnels within an MPLS network. This includes the creation of shortest-path LSPs, traffic-engineered SR policies with static paths, SR policies with dynamically calculated paths using distributed Constrained Shortest Path First (CSPF), color-based SR policies with Classful Transport resolution, backup paths with Topology-Independent Loop-Free Alternate (TI-LFA), and multitopology designs with Flex Algo.
This course also features a number of self-study modules, including a deeper dive into TI-LFA label stacks, and four modules on SRv6, including coverage on regular SRv6 SIDs and micro SIDs.
This course is based on Junos OS Release 23.4R1.10.

COURSE LEVEL

Advanced

AUDIENCE

- Individuals who work with routers that run Junos OS.
- Individuals involved in the service provider industry, the data center industry, or who work in large enterprise networks.
- Operators who use MPLS, BGP, and either IS-IS or OSPF to transport traffic across their network

PREREQUISITES

- Advanced routing knowledge the *Advanced Junos Service Provider Routing* course or equivalent knowledge is recommended
- Intermediate knowledge of MPLS transport functions, including LDP and RSVP; the *Junos MPLS Fundamentals* course or equivalent knowledge is strongly recommended
- Intermediate to advanced Junos CLI experience

RELATED JUNIPER PRODUCTS

- ACX Series
- Junos OS
- MX Series
- QFX Series
- Network Design
- Paragon Pathfinder
- PTX Series

RELATED CERTIFICATION

JNCIE-SP JNCIP-SP

CONTACT YOUR REGIONAL EDUCATION SERVICES TEAM:

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OBJECTIVES

- Review crucial MPLS concepts such as the label format, the inet.3 and mpls.0 tables, and BGP next-hop resolution.
- Demonstrate the building blocks of segment routing, such as adjacency SIDs and node SIDs.
- Describe some of the many features and benefits offered by SR-MPLS.
- Demonstrate how to enable and verify adjacency segments in IS-IS.
- Demonstrate how to enable and verify adjacency segments in OSPF.
- Demonstrate how to enable node SIDs in IS-IS to create a full mesh of shortest-path LSPs.
- Demonstrate how to enable node SIDs in OSPF to create a full mesh of shortest-path LSPs.
- Demonstrate the configuration and use cases for prefix SIDs and anycast SIDs.
- Configure SR traffic engineering policies that contain paths with an explicit SID stack.
- Describe how Seamless Bidirectional Forwarding Detection (S-BFD) can monitor an SR policy.
- Configure and verify SR policies with paths that contain explicit IP hops and binding SIDs.
- Demonstrate how SR policies can dynamically calculate a path based on your traffic engineering constraints.
- Describe the configuration for an SR policy that calculates its path dynamically.
- Demonstrate SR policy features such as computed segment lists and dynamic tunnels.
- Explain how TI-LFA backup paths can radically reduce downtime during link or node failure.
- Demonstrate how to configure and verify TI-LFA in a Junos OS network.
- Explain how the BGP color community can automatically map prefixes to a specific SR policy.
- Describe how Junos transport classes offer advantages in a network with color-based traffic engineering.
- Describe the advantages and operation of Flex Algo for SR-MPLS.
- Demonstrate how to configure and verify Flex Algo on a Junos OS device.

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Junos Segment Routing for MPLS

Education Services

OBJECTIVES (continued)

- Describe the process by which Junos OS calculates a label stack for TI-LFA backup paths in SR-MPLS.
- Explain how enabling microloop avoidance can solve problems that may occur during network convergence.
- Demonstrate some advanced SR policy concepts, including load balancing and external controllers.
- Demonstrate how to resolve color-tagged prefixes to SR policies using the legacy inetcolor method of resolution.
- Explain how SRv6 operates in contrast to SR-MPLS.
- Explain how SRv6 functions are a local instruction for a segment endpoint.
- Demonstrate how a stack of SRv6 SIDs is carried in the data plane.
- Explain how micro SIDs can compress multiple SIDs into a single SRv6 address.

COURSE CONTENTS

DAY 1

1 Refresher—MPLS, RSVP, and LDP

- Describe how BGP resolves its protocol next-hops
- Demonstrate how MPLS can create tunnels between devices
- Define some crucial MPLS terminology

2 An Introduction to Segment Routing

- Describe how segment routing combines segments to create an end-to-end-path
- Explain how segment routing efficiently advertises MPLS labels for shortest-path forwarding

3 The Use Cases for SR-MPLS

- Explain the benefits of shortest-path LSPs and traffic-engineered LSPs
- Describe some exciting features offered by segment routing, such as Flex Algo and TI-LFA
- Explain the difference between SR-MPLS and SRv6

4 Adjacency SIDs, Part 1—IS-IS

- Explain the consistent topology and the IP scheme used throughout this course
- Configure and verify SR-MPLS adjacency SIDs in IS-IS

5 Adjacency SIDs, Part 2—OSPF

- Configure and verify SR-MPLS adjacency SIDs in OSPF

Lab 1: Adjacency SIDs in SR-MPLS

6 Node SIDs and Shortest-Path Routing, Part 1—IS-IS

- Describe how the SRGB defines a block of MPLS labels for shortest-path forwarding
- Configure and verify node SIDs in IS-IS
- Enable explicit-null behavior for node and prefix SIDs

7 Node SIDs and Shortest-Path Routing, Part 2—OSPF

- Configure and verify node SIDs in OSPF
- Describe the link-state advertisements used by OSPF to advertise node SID information

Lab 2: Node SIDs in IS-IS and OSPF

Continued on the next page.

Junos Segment Routing for MPLS

Education Services

COURSE CONTENTS (continued)

DAY 2

8 Prefix SIDs and Anycast SIDs

- Configure and verify prefix SIDs and anycast SIDs in IS-IS and OSPF
- Enable BGP to use anycast SIDs in its protocol next-hops

Lab 3: Prefix SIDs and Anycast SIDs

9 Traffic Engineering—Static SR Policies with Explicit Label Stacks

- Describe how explicit and dynamic SR policies can create tunnels that take a precise path of your choosing
- Configure persistent adjacency SIDs
- Configure a CLI-based SR policy with an explicit SID stack

10 Traffic Engineering—Static SR Policies with S-BFD

- Demonstrate how S-BFD can monitor the status of an SR policy
- Configure and verify S-BFD on an SR policy in Junos OS

Lab 4: Traffic Engineering—Static SR Policies with Explicit Label Stacks

11 Traffic Engineering—Static SR Policies with Explicit IP Hops

- Configure a CLI-based SR policy with an explicitly configured path of IP addresses
- Explain the purpose of the traffic engineering database
- Demonstrate how binding SIDs can swap one incoming label for a stack of outgoing labels

Lab 5: Traffic Engineering—Static SR Policies with Explicit IP Hops

DAY 3

12 Traffic Engineering—Dynamic SR Policies with CSPF, Part 1

- Explain the purpose of CSPF and admin groups
- Demonstrate how to configure and verify admin groups

13 Traffic Engineering—Dynamic SR Policies with CSPF, Part 2

- Configure and verify a basic SR policy that calculates a dynamic path using TE metrics
- Deploy an SR policy with a compute-profile that contains traffic engineering constraints of your choosing

Lab 6: SR Policies with Dynamic Paths, Part 1

DAY 3

14 Traffic Engineering—Dynamic SR Policies with CSPF, Part 3

- Deploy an SR policy with a compute-profile that also references a segment-list path
- Configure On-Demand Next-Hops that automatically build SR policies to BGP next-hops

Lab 7: SR Policies with Dynamic Paths, Part 2

15 Topology-Independent Loop-Free Alternate—Theory

- Explain how TI-LFA creates loop-free backup paths with full topology coverage
- Describe the difference between link protection and node protection in TI-LFA

16 Topology-Independent Loop-Free Alternate—Configuration

- Configure Junos OS for TI-LFA with link protection
- Configure Junos OS for TI-LFA with loose node protection
- Configure Junos OS for TI-LFA with strict node protection
- Explain what types of traffic are eligible for local repair

Lab 8: Topology-Independent Loop-Free Alternate

DAY 4

17 Color-Based Traffic Engineering and the BGP Color Community

- Describe the format of the BGP color community
- Demonstrate how to configure an SR policy with a color
- Explain why Junos offers two different methods of enabling color-aware prefix resolution

18 Color-Based Traffic Engineering with Classful Transport

- Explain the advantages of resolving color-tagged prefixes using the Classful Transport method
- Configure automatic and manual transport classes
- Verify whether IP unicast prefixes have resolved using a transport class
- Verify whether VPN prefixes have resolved using a transport class

Lab 9: Resolving Color-Aware LSPs with Classful Transport

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Junos Segment Routing for MPLS

Education Services

COURSE CONTENTS (continued)

DAY 4 (continued)

19 Flex Algo, Part 1

- Explain the advantage of using Flex Algo to create multiple topologies with their own unique SPF metric
- Explain the meaning of algos 0, 1, and 128 to 255
- Configure the elements used to build a unique flexible algorithm definition

20 Flex Algo, Part 2

- Configure a Flex Algo topology using the Classful Transport method of resolution
- Verify and troubleshoot a Junos OS Flex Algo deployment
- Describe some important design considerations when deploying Flex Algo

Lab 10: Flex Algo

21 Where Do You Go from Here?

- Describe some of the ways that you can continue your SR-MPLS studies once you've completed this course
- Explain how to continue getting hands-on practice with Junos OS once the course is complete
- Describe the Juniper Networks certification track

SELF-STUDY MODULES

22 Topology-Independent Loop-Free Alternate—The Label Stack

- Explain how P space and extended P space find loop-free backup paths
- Demonstrate how Q space can be used to tunnel backup paths across topological loops
- Describe how adj-SIDs can bridge gaps between P space and Q space

23 Microloop Avoidance

- Describe how microloop avoidance can prevent temporary loops between two nodes during network convergence
- Configure and verify microloop avoidance in Junos OS

24 SR-MPLS—Additional Concepts

- Describe how SR policies can use multiple primary paths and a backup secondary path
- Explain how interface sets can offer unequal-cost load balancing
- Demonstrate how to create an anycast SR policy
- Describe how external controllers like Paragon Pathfinder use BGP-LS and PCEP to deploy LSPs across your entire network estate
- Explain why anycast SIDs require a consistent SRGB

SELF-STUDY MODULES

25 Color-Based Traffic Engineering with the inetcolor.0 Table

- Describe how the inetcolor.0 table resolves color-tagged BGP unicast prefixes
- Explain how to resolve BGP-based MPLS VPN prefixes in the inetcolor.0 table

26 SRv6—The Data Plane and Locators

- Demonstrate the data plane differences between SRv6 and SR-MPLS
- Describe the locator, function, and argument elements of an SRv6 SID
- Configure and verify locator prefixes in Junos OS

27 SRv6—End.DT4 and End.DT6 Functions

- Describe how End.DT4 and End.DT6 SIDs bind a packet to a routing table
- Configure End.DT4 and End.DT6 SIDs
- Verify End.DT4 and End.DT6 SIDs

28 SRv6—TI-LFA, End SIDs, and the Segment Routing Header

- Explain the purpose and behavior of the Segment Routing Header
- Demonstrate the hop-by-hop operation of the Segment Routing Header
- Describe the purpose of PSP, USP, and USD flavors for End SID and End.X SIDs
- Configure and verify End SIDs and End.X SIDs

29 SRv6—Micro SIDs and SID Compression

- Demonstrate how uSIDs solve the problem of packets with a large SRH
- Configure and verify micro SID blocks, locators, and uN SIDs
- Configure and verify local uSIDs such as uA SIDs and uDT SIDs

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